Wisconsin Geological and Natural History Survey

I. C. 6267

MAY, 1930

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
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POINTS TO BE CONSIDERED IN THE DESIGN OF COVERS FOR EXPLOSION-PROOF COMPARTMENTS

BY

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POINTS TO BE CONSIDERED IN THE DESIGN OF COVERS FOR EXPLOSION PROOF COMPARTMENTS[1]

By L. C. Ilsley[2]

One of the details which the engineers observe closely in conducting tests on explosion-proof type equipment at the Pittsburgh Experiment Station of the Bureau of Mines is the construction of covers and their means of fastening. These covers are of particular concern from a safety standpoint, because they are very liable to be frequently disturbed for the purpose of making inspection or repairs to internal parts of motors, controllers, etc.

When depended upon to permit frequent inspections it is desirable from a practical operating standpoint that the cover be easily and quickly removed and replaced. The position that has been taken by the Bureau of Mines is that the questio of ease with which covers will permit inspection should be determined by the manufacturer and the user. If the scheme used requires considerable effort, as in the removal of several bolts, it has been assumed that the one going to all this trouble to get the covers off could be trusted to put the cover back in place properly, especially as the approval plate generally calls specific attention to this point. Where a cover is simply screwed in place, fastened by a single bolt, or secured by a hing pin or other similar arrangement, the bureau has not been willing to assume that the cover would in all cases be properly fastened and has required further security by means of a lock or seal.

In the course of its investigations the bureau has had occasion to inspect and test five types of covers as follows: (1) Covers having two plane surfaces bolted together. (2) Covers having two plane surfaces held together by lugs, clamps, or other means besides bolts. (3) Covers which have screw thread and fit a similar thread in the compartment. (4) Covers having plane surfaces with the addition of a tongue-and-groove joint at about the center of the plane surface and in general secured by hinge pins or similar means of fastening. (5) Covers in the form of an annular ring accurately fitted to a motor shell which can be rotated around the shell, and thus make easy access to inspection openings in the shell and rotated back again to effectively seal these openings. Tests have also been made of large bolted covers having a smaller and more accessible cover within the large one, which could be opened for inspection purposes.

1- The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6267.

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Bolted covers are used quite generally for compartments that do not require frequent inspection. In designs using wide, properly machined surfaces with bolts of ample size and with carefully considered spacing there has been no difficulty in meeting the test requirements. Four schemes of bolting such covers have been adopted as follows: (1) Bolts or cap screws using bottomed holes in the compartment. (2) Studs which are screwed into bottomed holes. (3) Studs permanently riveted or welded in place when their removal would otherwise have through holes. (4) Bolts which pass through holes external to the compartment made possible by flange designs that extend beyond the casing walls. If the spacing does not exceed 5 or 6 inches between the centers of the bolt hole there should be little trouble from the passage of flames during the explosion tests made by the Bureau to prove the adequacy of compartments. Larger spacing has been found satisfactory in case of heavily ribbed or other reinforced construction.

In bolted-cover construction, other things being equal, bolts and cap screws are preferable to studs or counter-sunk machine screws. In the actual maintenance of equipment trouble has been experienced with studs. Where the threaded parts of the stud extend through the nut the threads become battered, and when an attempt is made to remove the nut the stud unscrews from the bottomed hole. Dirt gradually fills in the holes until there is so little depth left for the stud that the threads in the bottomed hole are stripped; then one must go to a great deal of trouble to replace the stud with the next larger size, redrilling the corresponding hole in the cover. To avoid this trouble, studs should never extend above the nuts. Burrs are also apt to be raised about the stud unless the bottomed hole is recessed.

In the case of flat-head cap screws it is difficult to determine by inspection whether or not the screw is exerting pressure on the cover or has become bottomed before drawing the cover in place. Special attention should be given to the length of this type of screw and special care taken that the bottomed hole does not get filled with dirt. Other cap screws are subject to the same objections, but to a lesser extent when in counterbored holes.

Ordinary cap screws are generally secured either by lock washers or by wiring through the heads of the cap screws. If lock washers are used the screws should be short enough to clamp the cover in place if the lock washers are left off or if a change is made from lock-washer fastenings to the wiring through the heads.

Sliding covers which wedge in place under lugs or merely make close fits under lug projections have been used only infrequently and have in general proved unsatisfactory in performance, besides being difficult to construct. This type of construction is not recommended.

The screw-type cover as originally designed has in every case passed the explosion tests. The reason for this is that, owing to the nature of the zigzag path through the threaded joint, flames rarely, if ever make their way to the outside of the compartment. Care should be given to the selection of a suitable thread design to permit ready assembly of the cover and to prevent easy damage to the thread in assembling. If large-size covers are supported on a hinged bracket to take the weight it facilitates their handling. In some designs manufacturers have turned off the first one or two threads on the cover to facilitate the starting of the thread, particularly on large-size covers. Screw-thre

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type covers should be locked. It is the usual practice to make the cover of some material that will not rust, such as aluminum or brass.

The tongue-and-groove joint is coming into quite general use. If properly constructed it can be made very effective and at the same time make the interior of a compartment readily accessible. The importance of correct design is evident from the fact that the first designs representing the product of four manufacturers permitted flames to pass and did not meet the test requirements until modified. There are a number of variables that need to be very carefully watched on this type of design, such as the depth and width of the groove, the closeness of the fit of the projection or tongue in the groove, the tolerance in machining that is to be allowed, the method of determining this tolerance accurately, the size and fit of the hinge pins, the degree of contact between the flat-surface portion of joint, and the rigidity of the covers under explosive Such covers should be padlocked. This design should not be adopted unless the manufacturer is willing to maintain a rigid inspection system which will include careful inspection of every compartment made.

The ring-type cover is somewhat special, having only been used on circular framed motors which could be adapted to this construction. It is undoubtedly rather an expensive design but one in which ample flange surface can be provided and one that permits of easy and ready inspection of the motor commutator and brushes. Such covers should be padlocked in position.

The bureau's final answer as to the adequacy of any type or design of cover is whether or not in actual explosion tests it is strong enough to stand the explosion pressure developed and whether it is tight enough to retain all flames within the compartment.

Three of the five types of cover described are the most generally used. These are bolted, screw, and tongue-and-groove designs. The advantages and disadvantages of these three types are summarized as follows:

The advantages of the bolted type of cover are that it permits of a large opening into the compartment, is comparatively cheap to construct, and is easy to inspect. The chief disadvantages are the time required for removal and replacement and the liability to neglect the proper security and tightening of all bolts. The flame path being in only one plane greater care must be used in both design and maintenance to insure the retention of flames in case an explosion takes place within the compartment.

The advantages of the screw type of cover when properly made are as follows: (1) There are no bolts, nuts, and lock washers to be lost or mislaid; (2) with the proper tool the cover can be quickly taken off or replaced; (3) the threaded joint is probably the easiest of any to make so tight that flames from an internal explosion will not escape; (4) usually one can tell by a visual inspection whether the cover is tight enough for safety; (5) the screw cover is simple to lock in place with either a padlock or some form of seal. The disadvantages of the screw cover are as follows: (1) Machining threads of such large diameter may present some difficulties, not so much with the cover itself as with the casting into which the cover fits; (2) the circular opening may not

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be adapted for use with the remainder of the design; (3) the ease with which the cover may be removed may tend to encourage opening the motor at times when opening would be unsafe; (4) this design does not readily permit of the maximum size opening into the compartment. Screw-type joints, if not made of different material, should be lubricated to keep from rusting together.

The advantages of the tongue-and-groove cover are as follows: (1) It permits a large opening into the compartment; (2) there being several directions which the flame must follow, this type of joint should be more effectiv in stopping flame than the plane flange design; (3) there are no bolts, nuts, or lock washers to be lost; (4) the cover can be quickly opened and closed; (5) this type of cover readily lends itself to locking in place either with a padlock or some form of seal. The disadvantages of the tongue-and-groove design are that it is expensive to construct and requires a very high order of inspection to insure that a uniform quality of product is being produced; moreover, the grooves are easily packed with dirt, and if not properly lubricated the joints are liable to rust together.

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